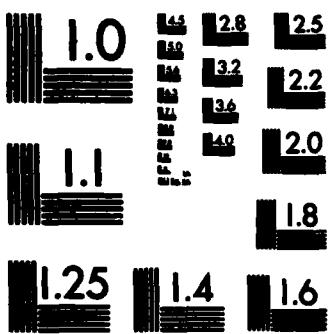


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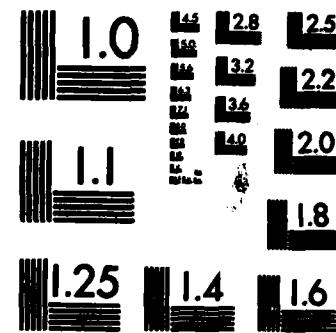
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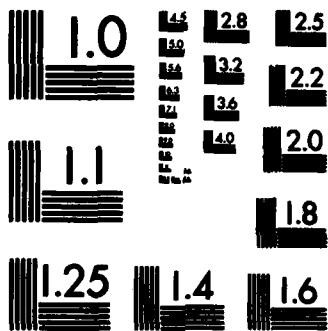
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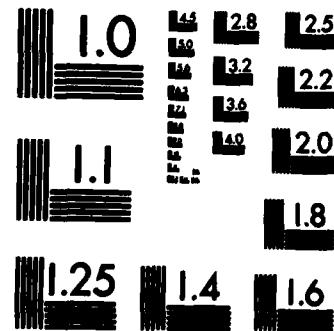
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NATIONAL BUREAU OF STANDARDS-1963-A



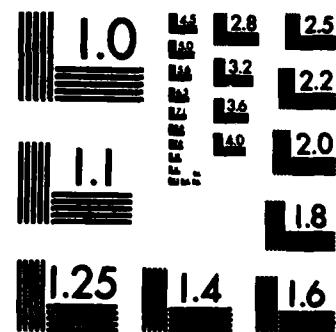
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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

AMRL-TR-75-50

Volume 150



AD A120508

USAF BIOENVIRONMENTAL NOISE DATA HANDBOOK

Volume 150

C-140 IN-FLIGHT CREW NOISE

SEPTEMBER 1982

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AEROSPACE MEDICAL DIVISION
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TECHNICAL REVIEW AND APPROVAL

AMRL-TR-75-50, Vol. 150

This report has been reviewed by the Office of Public Affairs (PA) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER



HENNING E. VON GIERKE, Dr Ing
Director
Biodynamics and Bioengineering Division
Air Force Aerospace Medical Research Laboratory

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The C-140 is a USAF transport aircraft used for operational support. This report provides measured data defining the bioacoustic environments at flight crew/passenger locations inside this aircraft during normal flight operations. Date are reported for seven locations in a wide variety of physical and psychoacoustic measures: overall and band sound pressure levels, C-weighted and A-weighted sound levels, preferred speech interference level, perceived		

noise level, and limiting times for total daily exposure of personnel with and without standard Air Force ear protectors. Refer to Volume 1 of this handbook, "USAF Bioenvironmental Noise Data Handbook, Vol. 1: Organization, Content and Application," AMRL-TR-75-50(1) 1975, for discussion of the objective and design of the handbook, the types of data presented, measurement procedures, instrumentation, data processing, definitions of quantities, symbols, equations, applications, limitations, etc.

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PREFACE

This report was prepared by the Biodynamic Environment Branch, Air Force Aerospace Medical Research Laboratory, under Project/Task 723109, Communication and Performance Capability and Operational Noises. The author acknowledges the efforts of Mr. John Cole who established the data analysis requirements, Mr. Henry Mohlman, and Mr. Fred Lampley of the University of Dayton who assisted in the mechanics of data processing and Mrs. Norma Peachey who typed this report and prepared it for publication.

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INTRODUCTION

The C-140 Jet Star is a transport aircraft used for operational support and is manufactured by the Lockheed-Georgia Company. The aircraft is powered by four J60-P-5A turbojet engines each rated at 3000 lbs. thrust. The engine is manufactured by the United Technologies Corp., Pratt & Whitney Aircraft Division.

This volume provides measured and extrapolated data defining bioacoustic environments produced inside the aircraft. Such data are essential to evaluate ear protection requirements, limiting personnel exposure times, voice communication capabilities, and annoyance problems associated with operations of the C-140 aircraft.

This volume is one of a series published by the Air Force Aerospace Medical Research Laboratory (AFAMRL) under the same report number (AMRL-TR-75-50) as a multi-volume handbook that quantifies the noise environments produced at flight/ground crew locations and in surrounding communities by operations of Air Force aircraft and ground support equipment. The far-field, community-type, noise data in the handbook describe the noise produced during ground operations of aircraft, ground support equipment, and other ground-based equipment or facilities.

Volume 1 of this handbook discusses the objectives and design of the handbook, the types of data presented, measurement procedures, instrumentation, data processing definitions of quantities, symbols, equations, applications, limitations, etc. Refer to Volume 1 (reference 1) for such information because it is not repeated in other handbook volumes.

A cumulative index lists those aerospace systems contained in the handbook, and identifies the specific volumes containing each type of environmental noise data available (i.e., inflight/flight crew and passenger noise, near-field ground crew noise, far-field/community noise). Volume numbers are assigned sequentially as individual volumes are published.

-
1. Cole, John N., USAF Bioenvironmental Noise Data Handbook, Volume 1: Organization, Content and Application, AMRL-TR-75-50(1), Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio, 1975.

IN-FLIGHT NOISE

MEASUREMENTS

All noise measurements were made on-board a standard-configured C-140 aircraft during typical speed, altitude, and flight maneuver conditions. These levels describe the standard C-140 environments, but may not be representative of those levels encountered if the aircraft has been configured differently (e.g., major equipment or structural changes).

Acoustic measurements were made at various flight crew and passenger locations. Table 1 lists the measurement locations and test conditions as numeric/alphabetic designators which are used on the data pages. The designator 1/A means measurement location 1 and test condition A.

The microphone position was at ear level external to headgear in a region 0.2-0.3 meter from the head when an individual was present. At unoccupied locations, measurements were made at ear level throughout a volume where the head would normally be located. In both cases, the microphone was randomly moved throughout a spherical volume approximately 0.3 meter in diameter and the resultant samples analyzed using a 4- or 8-second integration time to obtain a power-averaged level, which effectively smooths out short-duration fluctuations and best describes the exposure.

Although the presence of a crew member or passenger at a measurement location affects the resultant sound field, the magnitude of such effects is generally small and not significant in determining exposure limits or voice communication capabilities. Consequently, no distinction is made in this report between occupied and unoccupied measurement locations.

RESULTS

The measured data presented in Table 2 define the sound pressure levels (SPL) produced inside the C-140 aircraft at the seven specified locations. This table includes the overall, 1/3 octave band, and octave band levels. From these data, C-weighted and A-weighted sound levels, maximum permissible time for one exposure per day (AFR 161-35) with and without standard Air Force ear protectors, preferred speech interference level, and perceived noise level are calculated and presented in Table 3. These measures are widely used to assess the effects of noise on personnel and their performance.

TABLE 1

MEASUREMENT LOCATIONS AND TEST CONDITIONS
C-140, ANDREWS AFB, 7 JUNE 1982

LOCATION	POSITION	HEIGHT ABOVE DECK
1	Pilot/Copilot	Seated Head Level
2	Flight Engineer/Navigator	Seated Head Level
3	First Row Seats, Centerline	40" Above Deck
4	Second Row Seats, Centerline	40" Above Deck
5	Third Row Seats, Centerline	40" Above Deck
6	Fourth Row Seats, Centerline	40" Above Deck
7	Pantry Aft of Aircraft	40" Above Deck

CONDITION	DESCRIPTION
A	APU Running - Cockpit Door + Aircraft Door Open
B	Ground Runup, Idle
C	Taxi
D	Ground Runup, Military
E	Takeoff/Roll
F	Lift Off, Gear Up, Climb to 3,000 ft.
G	Cruise, 4,000 ft. - 250 KIAS
H	Climb thru 13,000 ft. - .55M
I	Cruise, 28,000 ft. - Normal Speed
J	Cruise, 28,000 ft. - High Speed
K	Cruise, 17,000 ft. - High Speed
L	Cruise, 17,000 ft. - Medium Speed, 300 KIAS
M	Cruise, 11,000 ft. - 300 KIAS
N	Cruise, 11,000 ft. - 250 KIAS
O	Descending to 8,000 ft. - Flaps 20°
P	Descending to 3,000 ft. - Flaps 20°
Q	Approach, Gear Down, 1,000 ft. - Flaps 45°
R	Landing, Touch Down, Reverse Thrust

TABLE: MEASURED SOUND PRESSURE LEVEL (DB)
1/3 OCTAVE BAND

2

NOISE SOURCE/SUBJECT: C-140
IN-FLIGHT CREW NOISE

OPERATION:

FREQ (HZ)	LOCATION/CONDITION											
	2/H	1/1	2/1	3/1	4/1	5/1	6/1	7/1	1/J	2/J	3/J	4/J
25	72	73	71	70	72	69	69	70	70	72	71	71
31.5	67	72	67	69	69	71	71	70	70	72	67	70
40	69	72	67	71	71	69	70	70	70	71	66	74
50	67	68	65	70	71	69	70	70	70	69	65	71
63	66	61	65	61	66	62	63	64	64	63	60	60
80	79	76	79	76	77	74	74	75	62	61	77	75
100	67	67	66	73	73	73	73	72	74	65	76	74
125	73	69	70	74	76	78	80	81	75	75	77	79
160	67	63	67	68	70	70	71	71	69	70	72	72
200	68	61	67	69	72	71	73	73	70	72	74	74
250	73	65	71	74	77	77	79	84	72	73	77	77
315	71	68	70	76	79	75	76	78	72	75	79	79
400	70	72	70	74	76	76	80	83	77	73	75	79
500	73	72	74	78	80	83	81	76	80	81	80	80
630	60	67	77	79	81	82	82	85	81	85	85	85
800	82	80	81	80	81	81	81	82	83	83	82	83
1000	80	80	81	80	78	79	78	79	83	84	80	79
1250	79	81	80	74	75	75	75	77	85	85	77	76
1600	79	81	82	73	74	73	73	75	96	96	76	74
2000	77	77	79	70	70	70	70	70	82	82	72	71
2500	73	74	76	67	67	67	67	67	68	68	73	69
3150	70	73	73	69	69	69	64	64	66	66	78	65
4000	67	70	72	59	60	61	61	63	74	74	76	62
5000	62	67	68	53	55	57	58	59	71	72	57	55
6300	59	63	65	51	53	57	58	61	68	68	55	55
8000	56	59	60	50	53	57	59	64	69	69	52	52
10000	54	56	56	48	51	55	57	61	69	69	52	51
OVERALL	91	89	91	89	91	89	91	93	93	93	92	91

LEVEL CORRECTED TO REMOVE BACKGROUND/ELECTRONIC NOISE.

TABLE: MEASURED SOUND PRESSURE LEVEL (DB)
2 1/3 OCTAVE BAND

NOISE SOURCE/SUBJECT:	OPERATION:	LOCATION/CONDITION									
		5/J	6/J	7/J	1/K	1/L	1/M	1/N	1/O	1/P	1/Q
C-140		25	73	71	73	72	72	74	72	73	69
IN-FLIGHT CREW NOISE		31.5	71	73	70	72	70	70	72	73	75
		40	72	74	74	70	70	72	75	69	70
		50	72	70	78	69	69	70	73	69	70
		63	91	80	97	82	82	79	82	71	69
		80	83	75	88	71	72	71	69	66	67
		100	80	74	74	67	67	71	69	64	65
		125	79	79	81	73	71	73	76	68	67
		160	74	72	77	66	65	65	71	59	64
		200	73	74	77	68	66	68	68	61	61
		250	80	77	83	71	70	70	75	62	61
		315	77	78	79	72	72	71	77	63	66
		400	80	80	80	73	72	72	74	65	69
		500	83	80	82	77	74	76	74	66	70
		630	83	84	85	81	80	80	76	71	60
		800	82	83	83	83	81	81	75	70	68
		1000	79	78	82	83	82	81	73	69	64
		1250	76	76	78	83	82	82	70	68	71
		1600	75	74	76	82	80	80	69	65	63
		2000	71	71	73	79	76	77	66	60	58
		2500	69	68	70	76	73	74	61	55	56
		3150	65	65	67	74	72	72	55	50	59
		4000	62	62	64	72	69	70	50	47	51
		5000	58	59	61	70	65	66	45	45	44
		6300	58	58	61	67	61	62	44	44	43
		8000	59	58	64	62	58	58	45	45	45
		10000	57	55	61	58	56	56	46	47	47
	OVERALL		94	91	99	91	90	90	87	81	85
											92

LEVEL CORRECTED TO REMOVE BACKGROUND/ELECTRONIC NOISE.

TABLE: MEASURED SOUND PRESSURE LEVEL (DB)
OCTAVE BAND
2

NOISE SOURCE/SUBJECT:	FREQ (HZ)	LOCATION/CONDITION							
		1/A	2/A	1/B	2/B	3/B	1/C	1/D	1/E
C-140	31.5	70	73	70	66	71	64	63	95
IN-FLIGHT CREW NOISE	63	67	67	74	66	70	62	62	81
	125	73	78	83	80	74	77	80	93
	250	72	77	74	72	70	71	61	90
	500	77	81	68	73	69	72	84	83
	1000	74	80	65	67	68	70	80	78
	2000	70	77	60	64	63	69	72	73
	4000	63	71	55	57	60	61	64	65
	8000	61	68	54	54	56	54	63	59
OVERALL		81	86	85	82	79	87	90	98
									87
									88
									89
									89
									89

IDENTIFICATION:

OMEGA 3.2

TEST CD-0882-001

RUN 01

20 JUL 82

PAGE J1

TABLE: MEASURED SOUND PRESSURE LEVEL (DB)
2 OCTAVE BAND

NOISE SOURCE/SUBJECT: OPERATION:
C-140 IN-FLIGHT CREW NOISE

IDENTIFICATION:
OMEGA 3.2
TEST CD-082-001
RUN 02
20 JUL 82
PAGE J2

FREQ (HZ)	LOCATION/CONDITION							
	2/H	1/1	2/1	3/1	4/1	5/1	6/1	7/1
31.5	74	77	73	75	76	74	75	72
63	87	82	86	82	87	83	84	97
125	75	72	73	77	78	79	81	83
250	76	70	74	79	81	80	81	86
500	91	79	80	83	84	84	87	97
1000	85	85	85	83	83	83	84	85
2000	82	83	85	75	76	75	77	88
4000	72	75	76	65	65	66	68	78
8000	61	65	67	55	57	61	63	67
OVERALL	91	89	91	89	91	89	91	98
								93
								92
								91

TABLE: MEASURED SOUND PRESSURE LEVEL (DB)
2 OCTAVE BAND

NOISE SOURCE/SUBJECT:		OPERATION:		LOCATION/CONDITION			
FREQ (HZ)		5/J	6/J	7/J	1/K	1/L	1/M
31.5		77	77	76	77	77	76
63	C-140	92	91	90	83	80	82
125	IN-FLIGHT CREW NOISE	83	81	83	74	73	74
250		82	81	85	75	75	76
500		87	87	87	83	81	82
1,000		84	84	86	88	87	86
2,000		77	76	78	84	82	83
4,000		67	67	70	77	74	75
8,000		63	62	67	69	64	64
OVERALL		94	91	99	91	90	90

(TABLE: MEASURES OF HUMAN NOISE EXPOSURE

3

		IDENTIFICATION:										
		OASLC 3.2	TEST CD-082-001	RUN 01	20 JUL 82	PAGE H1						
NOISE SOURCE/SUBJECT:	OPERATION:											
C-140												
IN-FLIGHT CREW NOISE												
HAZARD/PROTECTION C-WEIGHTED OVERALL SOUND LEVEL (OASLC IN DBC) AT EAR A-WEIGHTED OVERALL SOUND LEVEL (OASLA IN DBA) AT EAR MAXIMUM PERMISSIBLE TIME (T IN MINUTES) FOR ONE EXPOSURE PER DAY (AFR 161-35, JULY 73)												
NO PROTECTION												
OASLC	81	86	84	82	78	85	89	97	86	87	89	89
OASLA	78	84	73	74	72	75	84	83	80	86	86	87
T	960	480	960	960	960	960	480	571	960	339	339	285
MINIMUM APL EAR MUFFS												
OASLC	57	62	63	60	55	61	65	72	62	62	63	62
T	960	960	960	960	960	960	960	960	960	960	960	960
U-51R EAR PLUGS												
OASLC	55	60	50	51	48	52	61	62	56	61	62	62
T	960	960	960	960	960	960	960	960	960	960	960	960
FLENTS EAR PLUGS												
OASLC	54	60	51	51	48	52	61	63	56	61	62	61
T	960	960	960	960	960	960	960	960	960	960	960	960
H-157 IN-FLIGHT COMMUNICATION UNIT												
OASLC	59	63	63	60	56	61	65	72	63	63	65	65
T	960	960	960	960	960	960	960	960	960	960	960	960
COMMUNICATION PREFERRED SPEECH INTERFERENCE LEVEL (PSIL IN DB)												
PSIL	74	79	65	68	66	70	79	77	75	81	82	82
ANNOYANCE PERCEIVED NOISE LEVEL, TONE CORRECTED (PNLT IN PNDB), TONE CORRECTION (C IN DB)												
PNLT	90	97	90	88	87	91	97	97	92	97	98	98
C	1	1	2	1	2	1	2	1	0	0	1	1

* BASED ON CALCULATED SPL SPECTRUM UNDER PROTECTIVE DEVICE.

TABLE: MEASURES OF AIRMAN NOISE EXPOSURE

3

NOISE SOURCE/SHIELDING	OPERATION:
C-140	
IN-FLIGHT CLOTH MASK	

1/2/H 1/1 2/1 3/1 4/1 5/1 6/1 7/1 1/2 2/2 3/2 4/2

Location/Condition

HAZARD/PROTECTION C-WEIGHTED OVERALL SOUND LEVEL (OASLC IN DBC) AT EAR

A-WEIGHTED OVERALL SOUND LEVEL (OASLA IN DBA) AT EAR

MAXIMUM PERMISSIBLE TIME (T IN MINUTES) FOR ONE EXPOSURE PER DAY (AFR 161-35, JULY 73)

NO PROTECTION

OASLC	90	89	91	88	91	86	86	87	87	93	93	91	91
OASLA	89	89	89	85	86	86	86	87	88	92	92	88	88
T	240	240	202	404	339	339	285	285	240	120	120	101	240
MINIMUM OPL EAR MUFFS													
OASLC*	64	52	54	64	66	65	65	67	73	66	67	67	66
OASLA*	960	960	960	960	960	960	960	960	960	960	960	960	960
T													
U-51R EAR PLUGS													
OASLC*	63	62	63	62	63	62	62	64	64	66	66	65	65
OASLA*	960	960	960	960	960	960	960	960	960	960	960	960	960
T													
FLENTS EAR PLUGS													
OASLC*	62	62	63	62	63	62	62	64	64	66	65	65	64
OASLA*	960	960	960	960	960	960	960	960	960	960	960	960	960
T													
H-1157 IN-FLIGHT COMMUNICATION UNIT													
OASLC*	66	64	66	65	67	66	68	74	74	69	69	68	68
OASLA*	960	960	960	960	960	960	960	960	960	960	960	960	960
T													
COMMUNICATION PREFERRED SPEECH INTERFERENCE LEVEL (PSIL IN DB)													
PSIL	83	82	83	80	81	81	82	83	83	86	87	83	82

ANNOYANCE

PERCEIVED NOISE LEVEL, TONE CORRECTED (PNLT IN PNDB)	TONAL CORRECTION (C IN DB)	TONAL CORRECTION (C IN DB)
PNLT	100	100
C	1	1

* BASED ON CALCULATED SPL SPECTRUM UNDER PROTECTIVE DEVICE.

TABLE: MEASURES OF HUMAN NOISE EXPOSURE

2

BASED ON CALCULATED SPL SPECTRUM UNDER PROTECTIVE DEVICE.